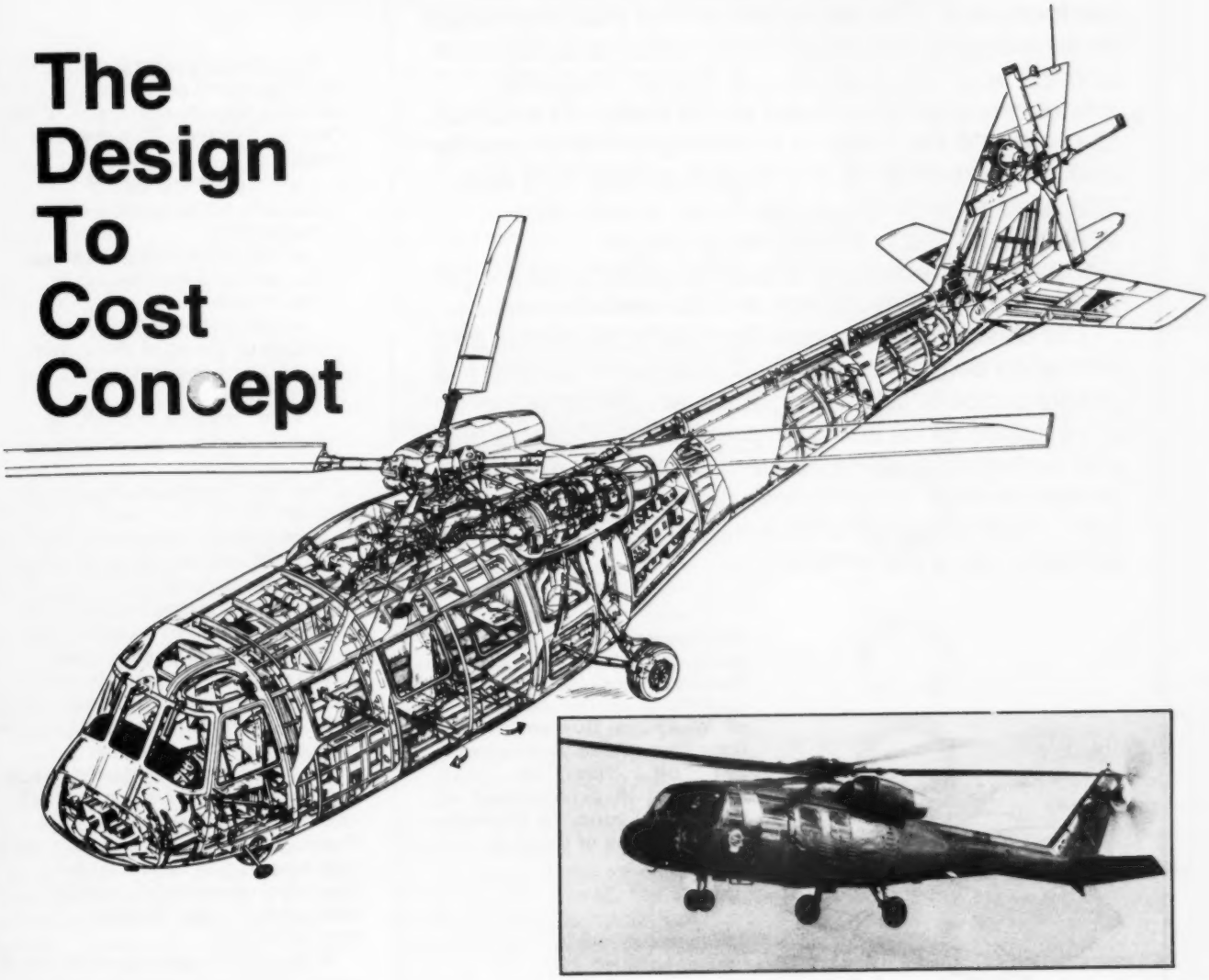
COMMANDER'S DIGEST

The Design To Cost Concept



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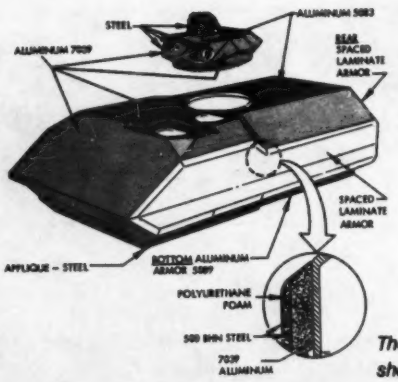
"In the area of cost control, we are giving increased attention to the design-to-cost concept. The objective of this approach is to induce designers to be cost conscious so that they will make tradeoff decisions based on cost versus performance. The establishment of predetermined cost ceilings is intended to filter down to subsystem and component level and to trigger redesign, where necessary, to meet these goals. In addition to providing flexibility in choosing levels of quality and performance in the design phase, it is also intended to provide tradeoffs on production schedule in the manufacturing phase. Comparisons among competing systems as well as within the existing system are also envisioned.

The design-to-cost approach is no panacea, and it must be selectively applied. It appears to offer the greatest potential in programs which have low development risk and high production. Component and subsystem development programs are good design-to-cost candidates. Along with acquisition cost, costs of ownership are also presented to the designer as a parameter."

Statement by Arthur I. Mendolia, Assistant Secretary of Defense (Installations and Logistics), on The Acquisition of Weapons Systems Hearings before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, Congress of the U.S.



The Army's Motorized Infantry Combat Vehicle shown in diagram form.

By
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The origin of design to cost (DTC) in the Department of Defense was DoD Directive 5000.1, Acquisition of Major Defense Systems. This directive required:

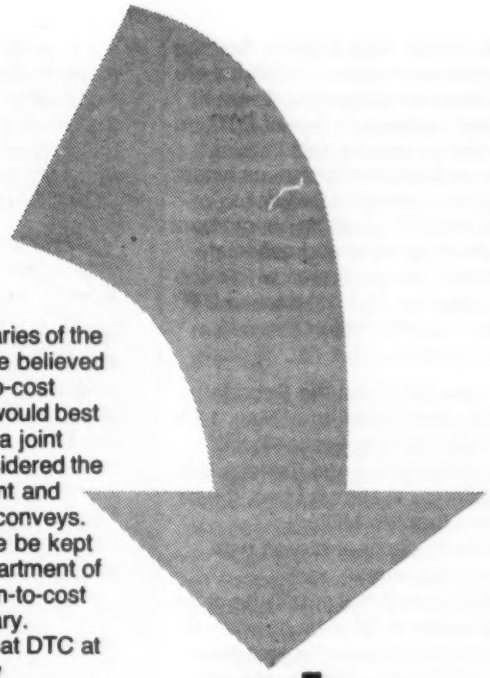
- The establishment of acquisition and ownership cost parameters;
- That these cost parameters be translated into "design to" requirements;
- That cost requirements be placed on an equal status with technical or performance requirements; and,
- That practical tradeoffs be made between cost, performance and schedule.

The directive makes it quite clear that the "design to" requirements are to cover total life cycle costs; however, it soon became apparent that it was not feasible to set finite dollar goals for operating and support costs during system design. The operating and support cost data base for past weapons was not adequate nor was there a proven system for measuring actual operating and support costs for individual defense systems.

Therefore, the early design-to-cost goals were established on production costs with Development Concept Paper (DCP) thresholds on operating and support cost factors such as personnel requirements, reliability, maintainability and training requirements.

While there is some question as to which defense system was actually the first DTC program it pretty much boils down to either the AX close support aircraft or the Stinger missile. By the end of 1972 there were about a dozen major defense system DTC programs.

DESIGN



TO COST

Not a panacea but a concept that offers great potential.

In June of 1973, Deputy Secretary of Defense William P. Clements, Jr. issued a memorandum to the secretaries of the Military Departments and the Defense Systems Acquisition Review Council (DSARC) to establish DTC goals for major defense system programs. This memorandum, which directed a major first step in DTC implementation, further required the following:

- DTC goals for those major programs that had not entered production as of August 31, 1973;
- DTC goals are to be expressed as average unit "flyaway" costs as defined in the DoD budget guidance manual, and to be reviewed by the DSARC;
- New programs to have DTC goals established early in development, no later than Milestone-II, the time at which the system enters full-scale engineering development; and
- Where DTC goals are not considered appropriate for the total defense system, DSARC review is required to determine degree of application.

This was the OSD policy direction that really got DTC implementation into high gear. In October 1973 the Joint Logistic Commanders approved, for information and guidance to their commands a joint design-to-cost guide (NAVMAT P5242, AMCP 700-6, AFLCP/AFSCP 800-19).

The commanders also recommended to their respective Service secretaries that the guide be submitted to the Secretary of Defense for consideration as a DoD guide for design-to-cost. The Deputy Secretary of Defense responded in a memorandum to the secretaries of the Military Departments that he believed acceptance of the design-to-cost guide at the working levels would best be served by keeping it as a joint service publication. He considered the guide an excellent document and endorsed fully the thrust it conveys. He requested that the guide be kept current and stated that Department of Defense would issue design-to-cost policy guidance as necessary.

It was fully appreciated that DTC at this point was quantitatively addressing only the production costs with operating and support costs, usually much larger, being considered more indirectly.

This was a primary reason for issuance of the memorandum, by Secretary Clements, in January 1974, on the subject of visibility and management of operating and support (O&S) costs. The task group established by the memorandum was directed to consider management focus, data needs, data systems and costs and system uniformity in developing a system for the management and accounting of these downstream costs on an individual weapon basis.

The task group effort is well underway and considerable data has been accumulated to date; mainly on Army helicopters and selected Air Force transport aircraft. The Military Departments are to submit their recommended detailed implementing plans by April 1975. I hasten to add, this will necessarily be a slow process and it will be several years before we have good historical data, thorough visibility of the O&S costs on existing systems and the capability to accurately estimate downstream costs for new weapons.

While DoDD 5000.1 states that the management principles it contains are applicable to all programs, it was found that implementation of DTC on the smaller programs was lagging. Also, there had been instances where the program manager had not established DTC goals on government furnished equipment and associate contractors, and programs where the prime contractor had not passed DTC on to some of his major subcontractors.

This brought about the Secretary Clements memorandum of May, 1974 which extended the application of DTC to subsystems and the less than major defense systems. Here, it was requested.that the Military Departments concentrate on new starts or programs in early development and that priority be given to those systems of subsystems with anticipated large quantity production. Further emphasis was also placed on cost vs. performance trade-offs and the importance of reliability and future costs.

The DoD Directive, JLC Guide and three Deputy Secretary of Defense memorandums relating to DTC, that we have just reviewed, represent the current OSD policy and direction on the subject. We do plan to issue a short DoD directive on DTC in the near future.

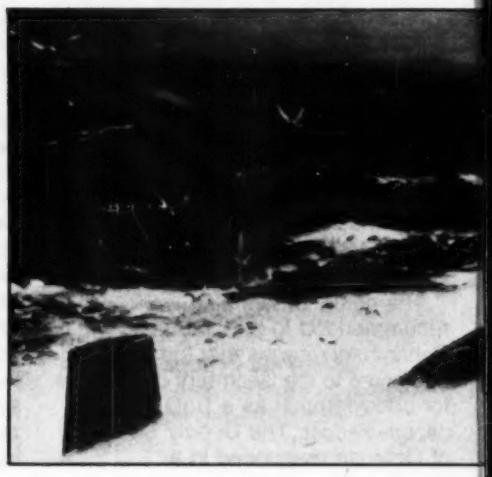
In response to Secretary Clements' request for DTC goals on major defense systems (June 1973 memo) the Military Departments submitted their recommended numbers or a date, prior to Milestone-II, for establishing these goals. The recommended goals were reviewed by the DSARC, and after some negotiation, the approved DTC goals were forwarded to the Service secretaries in a memorandum from Secretary Clements in July of this year.

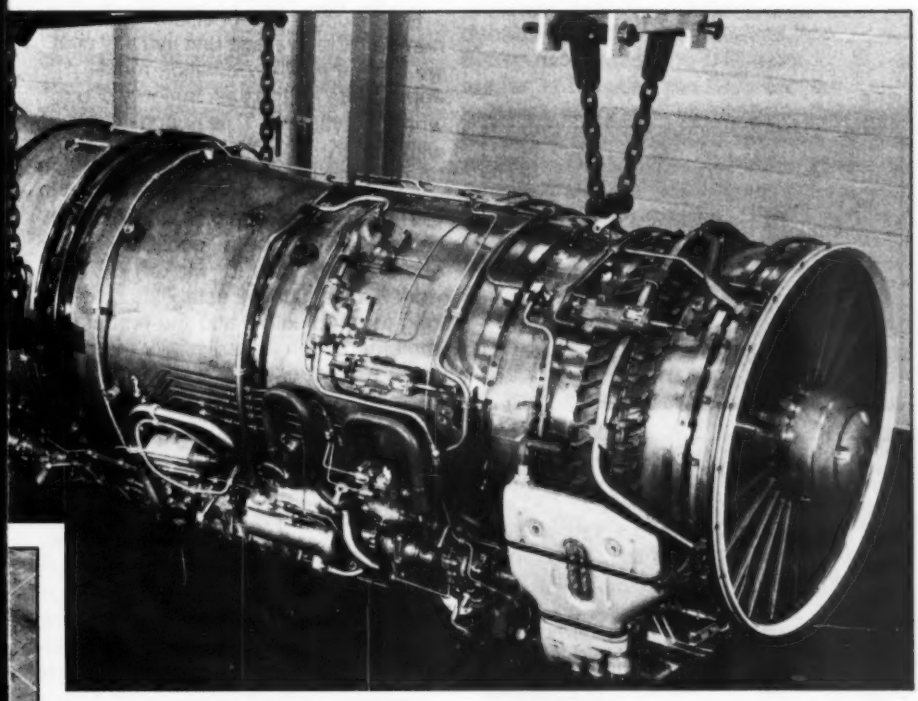
A summary of the status of DTC implementation on major defense systems is presented here:

- There were 75 major defense systems in the DCP/DSARC system.
- In addition there were 13 major systems in the Systems Acquisition Report (SAR) system that have been in production for quite some time and were therefore never under the DCP/DSARC system.
- DTC goals have been established as the average unit flyaway cost for 24 programs.
- DTC goals have been established for two programs where for system peculiar reason average unit flyaway cost was not used.
- 22 programs have agreed-to-dates for establishing DTC goals and prior to the Milestone-II DSARC.
- There were 21 DCP/DSARC programs that entered production prior to August 1973; thus, not requiring DTC goals.
- For six programs it was agreed that DTC was not appropriate for the entire system; however, individual projects and subsystems within these programs are to have DTC goals where appropriate.
- 48 out of 54 major defense systems, that have not yet reached production, or about 90 percent either have or will have DTC goals established prior to entering full-scale engineering development.

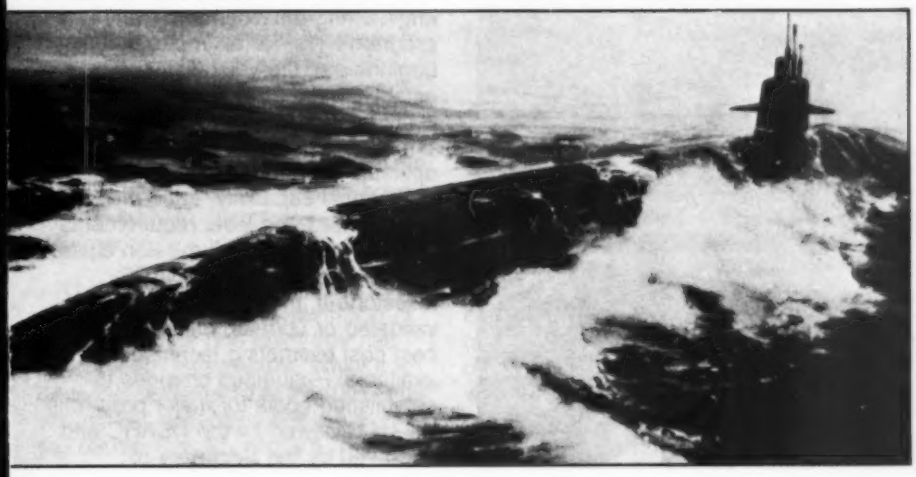
The program coverage of this initial implementatiion of design-to-cost is encouraging; however, at best, this represents less than half of the total Department of Defense acquisition budget (Development and Procurement). The other half goes for less than major defense systems, plus other goods and services.

It should also be pointed out that only about half of the programs that currently have DTC goals had these goals established prior to the start of full-scale engineering development.





Component and subsystem development programs are good design-to-cost candidates. The Pratt & Whitney F-100 turbofan (above) powers the Air Force's YF-16 lightweight fighter (insert). Below, the Navy's proposed missile submarine, the Trident, with its many subsystems, is shown in an artist's rendering.



When considerable design has been accomplished prior to setting the goal, managing to cost is probably more descriptive of the desired cost control. It was decided, however, to standardize on design-to-cost in order to prevent the confusion of added terminology. As for those few programs near the production decision, Milestone-III, the DTC goals were set essentially at the program manager's best estimate of the average unit flyaway cost.

Now as for a DoD Directive on DTC; we are working on such a document; the first coordination cycle, including the Military Departments, has been accomplished; most everyone thinks we need such a directive and we hope to have it on the streets in January. It will be a brief document establishing policy and guidance on the application of DTC principles to the acquisition of defense systems, subsystems and selected components. Keep in mind that we are still only implementing the first phase of the DoDD 5000.1 DTC concept.

Here is our most recent definition of the DTC concept:

"The establishment of cost goals early in the development process and the management and control of future acquisition, operating and support costs to these goals by the conduct of practical tradeoffs between system capabilities, cost and schedule."

This is really what we want from DTC, but it just isn't practical at the present time due to the lack of good operating and support cost historical data. The directive, therefore, will not require any changes in the present DTC definitions. A general definition of DTC goal is as follows:

"A specific cost number, in constant dollars, based upon a specified production quantity and rate, established early during system development as a management objective and design parameter for subsequent phases of the acquisition cycle."

One phase of the design-to-cost objective is to choose the optimum system in terms of operational capability, adequate quantity for force-level requirements, and affordable overall mission costs.

By making the "specific cost number" the average unit flyaway cost we have the DTC definition most appropriate for the vast majority of our weapon systems. This is consistent with the present DTC policy, and will be retained in the new directive.

The DTC directive will establish policy; it will not be a "cookbook" approach on "how to" make DTC work. DoDD 5000.1 established the long-term objective and the first step implementation is essentially the same as requested in Secretary Clements' memorandum of June 1973.

Although the DTC goal includes only flyaway cost, the management objective during development must still include the control of future operating and support costs. The major operating cost factors, for instance those related to reliability, maintainability or manpower requirements, which contribute significantly to life cycle costs, shall be carefully considered and made thresholds in the DCP for all DTC programs. Unit cost, total acquisition cost and operating and support cost tradeoffs must be examined during development to insure that the new system is being introduced to the force structure at the least total cost.

We want the DTC goal established as soon as feasible in development, but not later than entry into full scale engineering development. Early in a program's life, for example, at the beginning of the validation phase, establishment of the goal will most likely be based on affordability limits. The objective is to choose the optimum system in terms of operational capability, adequate quantity for force level requirements and affordable overall mission costs. As the program nears DSARC Milestone-II, the DTC goal will be validated or updated using all of the best cost estimating techniques available. Requested changes to established goals for major programs will be reviewed by the DSARC and approved by the Secretary of

Defense. Revised DTC goals will normally be requested for major changes in program structure or mission requirements, for changes where a significant demonstrable reduction in life cycle costs can be achieved, or for other program changes beyond the control of the program manager.

DTC goals for other than major programs will be established and controlled within the Military Department or Defense agency. Approval authority for the goals and changes to the goals will be maintained at a management level above the program manager.

In applying the design-to-cost concept to a new system, it is essential that a determination be made of the minimum acceptable performance and force levels which are required to assure the needed capability. This will allow the maximum flexibility for subsequent tradeoffs of performance to achieve DTC goals, for if there is nothing to trade, the concept cannot work.

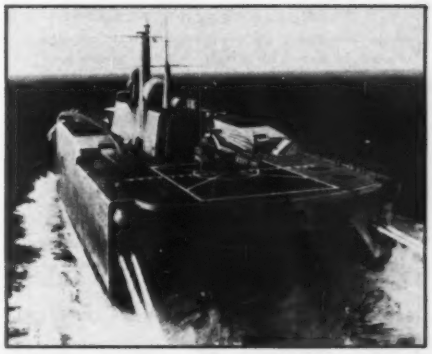
The program manager must have the authority, responsibility and accountability for ensuring that provisions for DTC goals are included in request for proposals and contracts for his program. He must also be responsible for allocating the program DTC goal among the various system elements. All subordinate goals and unit production cost figures must be retained for the program manager to tailor the application of DTC to his particular program requirements and characteristics in the manner that is most advantageous for that program. Just as no two programs are alike, the implementation of DTC has to have the flexibility to accommodate these differences.

That about covers where we stand on policy and the implementation of DTC except for one point that has been rather controversal. While it is generally accepted that the DTC goal should be challenging but achievable, the relationship to program "best estimate" average unit flyaway cost is debatable. It is my personal opinion that in most cases the DTC goal, agreed to between the OSD and the Military Department, should be slightly below the approved program "best estimate". This position is certainly not based on our past performance in estimating defense system costs, but rather on the improvements we have made in cost estimating, both industry and government, in the past few years.

Unrealistic original cost estimates on past programs are a matter of record and unquestionably have been responsible for a significant part of the cost growth in the "horror cases" that have been so well publicized. We believe that the current emphasis on independent cost estimates has gone a long way to correcting this situation. At least two independently conducted cost estimates plus an evaluation of these estimates by the OSD Cost Analysis Improvement Group (CAIG), are presented to the DSARC at each program milestone review. The DSARC then recommends to the Secretary of Defense an appropriate DTC goal for the program and, if there are significant differences in the cost estimates presented, a program "most likely" cost is also recommended. I believe that our present cost estimating methods, which rely heavily on historical data, reflect the program impact of the unrealistically low initial estimates of the past and that the cost performance on our newer programs should improve.

The OSD does not plan to get into the detailed "how to" aspects of DTC; however, as we have received comments on the proposed directive, reviewed a few major programs, attended DTC symposiums and talked with various industry people, it was inevitable that we would draw some conclusions regarding the application of DTC principles. The following sort of checklist has been compiled and we will submit it to the joint logistic commanders for consideration when updating the joint DTC guide:

In applying the design-to-cost concept to a new system, it is essential that a determination be made of minimum acceptable performance and force levels which are required to assure the needed capability.



During mid-November, the Air Force's newest bomber, the B-1, was rolled out at the Rockwell aircraft plant in California, and made its first flight in December.

•The program office and the prime contractor should have a statement of the required operational capability defined in terms of the military mission and operating forces will perform with the defense system. This is the key to tradeoff flexibility, without it, minimum acceptable performance goals will be difficult to establish.

•Include in the contract the technique which will be used to translate the constant fiscal year dollar DTC goal into current year dollar values and also the technique for adjustment of the goal for approved changes in quantity.

•Use end-item performance goals or specifications, selected to allow maximum tradeoff flexibility, rather than detailed design specifications for systems, subsystems and components. This is hard to do—we have quite a few detailed design specialists in DoD, and they have their counterparts in industry.

•Establish thresholds for program managers which specify their authority to make tradeoffs within the overall cost, schedule, and performance requirements of the program.

•Use standardization concepts whenever it is possible to do so without limiting flexibility to meet design-to-cost goals.

•Personnel and training cost factors should be considered early in the development process so they can influence the design tradeoffs.

•Maintain competition among contractors and/or alternative systems or subsystems as long as it is economically justifiable.

•Devote sufficient development time and resources to initiate designs to reduce future costs and along with that, involve production engineers in the earliest stages of design to help eliminate those components that will be difficult to produce.

•Select a procurement strategy during development and production which motivates the contractor to strive toward lower production costs and lower operating and support costs. This could be any combination of competition, contract incentives, award fees, options, contractor maintenance or warranties.

•Pay attention to the high cost items. In many designs some small percentage of the items amount to most of the costs. By knowing the costs, and by listing items in order of descending costs, it is possible to direct your attention to the high cost items where the payoff is greatest.

As a final caution; we cannot allow people designing to cost to tradeoff capability or quality to the point of developing inferior equipment. We have to insure that the minimum acceptable capability is well defined, and that it remains the paramount program threshold.

Our major defense programs take, on an average, about five years to complete development so we cannot, as yet, present case histories of how the design-to-cost concept worked on any particular program; however, the basic concept of establishing a cost goal and designing to that goal by the conduct of practical tradeoffs between system capabilities, cost, and schedule is sound and has worked successfully in many commercial development programs. With the continued enthusiastic support of all of you, we will make the design-to-cost concept successful in the acquisition of DoD major systems, subsystems and related components.

COMMANDERS DIGEST

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